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JPRS L/9144

17 June 1980

USSR Report

TRANSPORTATION

(FOUO 2/80)

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17 June 1980

USSR REPORT

TRANSPORTATION

(FOUO 2/80)

CONTENTS

RAILROAD

HIGH-SPEED OVERLAND TRANSPORT

Moscow VYSOKOSKOROSTNYY TRANSPORT BUDUSHCHEGO in Russian 1979 pp 40-45, 51

[Article by I. V. Amelichev; A. S. Antipov; I. A. Ivanov; G. S. Khvostik: "Investigation of the Track Structure, Volume and Cost Characteristics of an Elevated Track for High Speed Overland Transport (VSNT) with Electromagnetic Suspension"]

[Text] In recent years, the problems of the magnetic suspension of transport vehicles and train traction by means of linear motors are becoming more important. Concrete technical solutions to these problems are already available and they have already moved from the fantasy into practice today and the very near future. Many countries are involved in creating the new type of transport. Work on it is being done in the United States, England, Canada, France, Japan and the FRG.

In our country, investigations are being made comprehensively on a plan basis for a problem whose purpose is to develop and create a VSNT system with magnetic suspension, linear tractive electric motors and automatic control providing speeds of 350 to 500 km/hour. According to the plan, the first stage of the investigation is the problem of evaluating feasible areas for applying high-speed passenger service transport with magnetic suspension and to determine preliminary parameters for the track, the motive power and requirements for them. For the technical-economic evaluation of possible areas for applying the VSNT with magnetic suspension, it is first necessary to have the most complete and authentic data on the cost of the elevated track complex and its operation, because from experience in building RRs for wheel transport, it is well known that 70 to 80% of the total cost of the line is expenditure for building the track and man-made structures.

1. Basic Parameters and Characteristics of the VSNT System

In the All-Union Scientific Research Institute of RR Transport, the Institute of Complex Transport Problems and the All-Union Scientific Research Institute of Electric Locomotive Building, preliminary specifications were developed for the structure and basic parameters of the VSNT system with magnetic suspension and linear tractive motors.* The preliminary requirements concern the basic parameters and characteristics of the vehicle and its systems, track structure, power supply, organization of movement and technical-economic evaluation.

In the part concerning the track structure, these requirements were formulated as follows:

the system is intended for future uninterrupted interurban and suburban passenger transport;

the rated maximum speed -- 400 km/hour;

weight of vehicle with passengers -- 40,000 kg-force;

the tractive force for the vehicle is produced by linear induction motors and is determined from the condition of creating an acceleration of $1 m/sec^2$ at the platform to a speed of 300 km/hour with the following acceleration to the rated maximum speed with an acceleration of $0.5 m/sec^2$ taking into account aerodynamic and magnetic resistances;

the width and height of the vehicle according to size T of GOST 9238-73;

length of vehicle along the coupling axes -- 25m;

train composed of ten vehicles;

vehicle suspension -- electromagnetic;

system for guiding vehicle-electromagnetic;

electromagnets for suspension and guiding must move the vehicle with pole gaps with respect to suspension and guiding busbars equal to 20mm with allowable deviations of ±5mm for combined forces in ton-forces;

Weight of vehicle	40
Centrifugal forces of profile and local surface irregularities	±8
Vertical aerodynamic forces, horizontal transverse aerodynamic forces	10
Forces of residuals accelerations when passing curves taking into account local surface irregularities	8

* The authors of the article did not participate in the development of requirements.

- service braking is electrical. In this case, the braking force is determined by creating a vehicle deceleration of 1m/sec^2 on the platform taking into account the weight of the vehicle and the aerodynamic resistance;

- special braking is electrical with a maximum decleration of 3m/sec^2;

- emergency braking is frictional with a slide block and aerodynamic with 3 to 6m/sec^2 deceleration. When the power and suspension control systems fail, the vehicle is lowered onto the guide busbars; provision should be made that slide blocks not be damaged if the vehicle has to made a single stop when moving on them;

the main line is double track;

the track is laid on the reinforced concrete trestle on which are installed steel guides and overhead busbars, the reactive busbar of the linear induction motors and current-carrying devices;

the distance between the axes of the parallel tracks is not less than 8000cm;

- the distance between the busbar axes of the suspension is 2650mm;

the distance from the ground level to the lowest point of the rolling stock is not less than 2000mm;

no sidings or switches are planned along the entire line;

in addition, the deviations of the working surfaces of the busbars (grade, direction and reactive) from the nominal geometry are made more precise;

track grades should be no greater than 150^{o}/oo;

on vertical and horizontal transition curves of the track the speed of increased acceleration should not exceed 0.5m/sec^2;

the track slope on horizontal curves should not exceed 12^{o};

- the track should be designed to meet the most unfavorable combination of loads taking into account the movement of two trains made up of ten vehicles each moving in opposite directions, taking into account the tractive, inertial forces and wind load of the vehicle, as well as forces acting when special and emergency brakings are applied;

distinct points for interurban transportation should be no more frequent than 200 to 300km;

the vehicles operate eighteen hours per day;

switches to be installed at terminal stations to move the trains to the return track;

required capital investments and operational costs are determined for each division (track, rolling stock, power supply devices) on the basis of the adopted track structure, parameters of the rolling stock and the selected system for repairs;

the technical-economic evaluation is made by the method of comparative calculations (a special high speed rail line with v = 250 km/hour and aviation transport are used as the basis of comparison), according to the absolute efficiency of capital investments;

comparative technical-economic calculations are made according to reduced expenditures for a period of fifty to sixty years;

in comparing the elevated track with the usual track on the ground, the saving is estimated for track repairs, elimination of losses of valuable land otherwise required for ground tracks, the elimination of small man-made structures, pits, fills, reduction in excavations, elimination of ballast, ties, etc.

The formulated preliminary specifications, coordinated by an interdepartmental conference, were used as a basis in the investigations and in doing exploration work on the track structure and the volumetric characteristics of an elevated track for the VSNT with magnetic suspension.

2. General Design and Operating Requirements for a Track for the VSNT with Magnetic Suspension

Minimum costs of construction and installation of a track for the VSNT with magnetic suspension may be obtained only when general requirements are imposed and implemented to the fullest extent applying equally to the developments of any track systems intended for operation under promising conditions and long distances. Such requirements are:

high rate of construction;

maximal prefabrication of structural track components;

mechanization and automation of assembly, debugging and start-up of system operation with minimal manual labor;

high efficiency of construction and operation that assumes maximum standardization of components and units of structures and their interchangeability;

technical possibility of round-the-year work on construction and operation with low man-hours per job.

At the same time, a number of new in principle requirements are to be imposed on the solution of the considered complex of problems of the track system. These requirements are related to the differences of the VSNT from the usual wheel transport. Special features of the VSNT are high speed trains (400 km/hour and greater) and correspondingly greater requirements of safety and a comfortable ride, short headway between trains and long line. This, in turn, imposes such additional requirements in solving the track problem for the VSNT as:

high accurate maintenance of the guiding gage, which is possible only by creating a track design of especially high reliability, stability and durability;

creating and debugging special design units to achieve and maintain the guiding gage within required precision limits to compensate for possible deviations of the track in the process of construction and operation;

eliminate the possibility of doing track work in intervals between train movements and doing the work in intervals on strictly limited schedules and at the time of the day when there are no train movements;

high efficiency of design.

More than a century's experience in operating track on the ground indicates that to create and maintain a track with such high requirements as those presented to the track structure of the VSNT is practically impossible and the line electromechanical complex must be located on elevated supporting structures.

Therefore, the problem is reduced to the evaluation of the volumetric and cost characteristics of an elevated type of track with magnetic suspension for the VSNT. The solution of this problem is complicated by the fact that it precedes the solution of almost all basic problems that make up the track and associated track equipment as applied to the VSNT with magnetic suspension. There are still no developments of the design of the electromechanical complex of carrying and guiding devices, of the design of the elevating supporting structures, methods of their construction, operation and repairs. There are no norms, requirements and regulations for designing the route of the line, as well as for the carrying structures themselves, which would take into account the specifics of the high speed movement of trains with magnetic suspension. The possible directions for such high speed lines have still not been determined and the value of a number of parameters, adopted only as estimates to start the work, is also controversial. Under such conditions, the only acceptable approach was the decision to use, to the maximum extent, the available experience in designing and building high speed RR lines and man-made structures for them (bridges, trestles) in accordance with existing norms for RR wheel transport with corresponding corrections for the special features of the loads due to the electromagnetic suspension.

Methodologically, the work on determining the volumetric and cost parameters was done in the following manner.

To determine the cost of the elevated track, it is necessary to know the cost of $1m^3$ of reinforced concrete now and long-range and its average consumption per one track-meter of the trestle. The latter, in its turn, depends on:

a) rated loads on the elevated track;

b) the structural shapes of the span structures and pillars adopted;

c) the length of the span beams and the height of the pillars. The lengths of the span beams are related to the height of the pillars by certain optimal relationships that insure a minimum total consumption of material. The height of the pillars depends on given route conditions and the location of the elevated track above the ground, as well as on the ruggedness of the terrain and its topography.

To establish to the first approximation the norms for laying out the route for the VSNT with magnetic suspension, maximum accelerations were used which were recommended by preliminary specifications, as well as by additional conditions for riding confort using data of domestic and foreign investigations.

The Moscow-South route for high speed rail transport was assumed as an analog. The route profile was determined for various inscribed radii in the vertical plane and for two different values of minimum heights of the elevated structure. The obtained spectrum of elevated structure heights along the length of the sections was conditionally distributed along the entire length of the route. The consumption of reinforced concrete in accordance with a special, method described below, and the total cost of various versions of the track for moving the VSNT, taking into account the present and long-range cost of the reinforced concrete, was determined for the found heights of the elevated track.

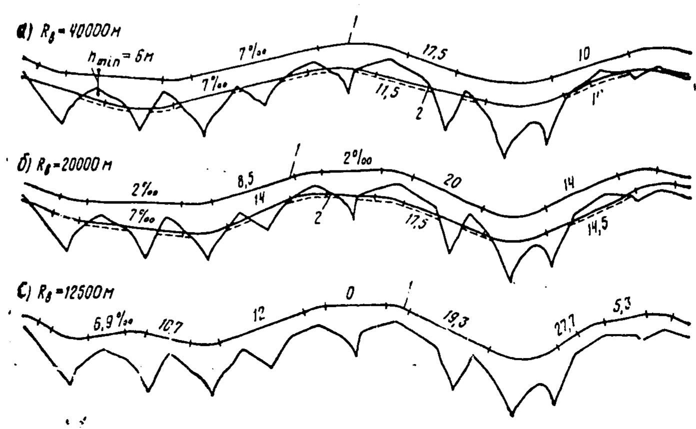

Fig. 2. Terrain topography of one of sections of the Moscow-South line and the terrain topography of the VSNT route for various routing conditions:

a -- R_B = 40,000m; b -- R_B = 20,000m; c -- R_B = 12,500m:

1 -- for height of 6m above ground; 2 -- for height of 2m above surface of ground in depressions.

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OCEAN AND RIVER

MAIN MARITIME ROUTES OF CARGO FLOW DESCRIBED

Moscow EKONOMICHESKAYA GEOGRAFIYA TRANSPORTA SSSR in Russian 1977 pp 124-128

[Excerpt of Section 17 by S. K. Danilov: "Principal Routes of Freight Traffic in Maritime Transport" from the above textbook approved for use in institutions of higher learning of the USSR Ministry of Railways]

[Text] Transportation on the Black and Azov Seas. Petroleum, mineral construction materials, ore, timber, metals and coal make up the cargoes or freight traffic in maritime transport. The Black and Azov Seas provide transportation for the Ukraine, the Northern Caucuses, and the Transcaucuses. The construction of the Volga-Don Canal imeni V. I. Lenin has permitted carrying out transportation between the Black, Azov, and Caspian seas. The socialist countries of Europe which have strong economic relations with the USSR open onto the Black Sea. Through the straits of the Bosporous, the Sea of Marmara, and the straits of the Dardanelles foreign trade cargoes flow from the Black Sea through the Mediterranean Sea and the Atlantic Ocean to countries in Western Europe, America, and Africa. (Figure 27)

In freight turnover (departures and arrivals), the ports of the Black and the Azov Seas, with 44% of the freight turnover in maritime transport, occupy first place in the USSR. Over half of this traffic is foreign trade. According to the amount of exports and imports, Odessa occupies first place among USSR ports. (In freight turnover, it is second after Baku). The port of Il'ichevsk (near Odessa),created during the years of Soviet rule, has turned into a major port. Among the major ports along the coast of the Black Sea are Poti, Novorossiysk, Batumi, and Tuapse. The port of Poti receives the largest ocean-going ships all year around. The largest ports at the mouths of rivers are Nikolayev and Kherson on the Dneiper, and Reni and Izmail on the Danube. The Black Sea holds first place in transportation between seas. There is also,in the Black and Azov Seas, a rather significant amount of coastwise transport. Almost 90% of cargoes received from railroads for coastwise transport in the basin are transshipped in the ports of Zhdanov, Novorossiysk, Poti, and Batumi.

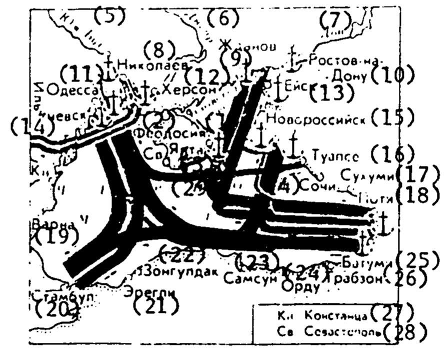

Figure 27. Freight Traffic on the Black and Azov Seas.

1. Azov Sea
2. Feodosiya
3. Yalta
4. Sochi
5. South Bug River
6. Dneiper River
7. Don River
8. Nikolayev
9. Zhdanov
10. Rostov-on Don
11. Odessa
12. Kherson
13. Yeysk
14. Il'ichevsk
15. Novorossiysk
16. Tuapse
17. Sukhumi
18. Poti
19. Varna
20. Istanbul
21. Ergli
22. Zonguldak
23. Samsun
24. Ordu
25. Batumi
26. Trabzon
27. Konstantsa
28. Sevastopol'
29. Black Sea

Azov and Black Sea ports receive grain from the Ukraine and the Northern Caucuses, coal from the Donets Coal Basin (mainly through Zhdanov), iron ore from Kerch, Manganese ore from the Ukraine (through Nikolayev) and from the Caucuses (through Poti), petroleum and petroleum products from the Caucuses (through Batumi and Tuapse), machines and equipment from the Ukraine (through Black Sea ports), cement from Novorossiysk, and fruits from the Soviet subtropics. The predominant cargoes transported on the Black Sea are machines and equipment, grain, petroleum, ore, and cement. The main maritime exports are petroleum, coal, and ore. Petroleum, grain, coal, cement, and ore from Chiatura make up most of the traffic in transport between seas. The predominant cargoes on the Azov Sea are coal, iron ore, salt, fish, and mineral construction materials. The most important port on the Sea of Azov is Zhdanov. Great quantities of manganese ore from Chiatura arrive in the port by sea.

Transportation on the Baltic Sea. More than 80% of the freight turnover in the Baltic Sea consists of exports and imports. The importance of Baltic Sea transportation has grown in connection with the recent increase in foreign trade. The Baltic Sea is the most convenient route for shipments between the USSR, Poland, the GDR, and other Baltic countries. The shortest route from the European part of the Soviet Union to the USA is through the

Baltic Sea and across the Atlantic Ocean. Between-seas navigation to ports in the Black, White, and Barents Seas is of great importance in the transport operations of the Baltic shipping company. Also, coastwise transport is carried out between the Baltic ports of Leningrad (the most important port), and Tallin, Riga, Liepaya, Klaipeda, and Kaliningrad. (Figure 28) In freight arrivals at Baltic ports, the principal cargoes are coal, timber, petroleum, and mineral construction materials.

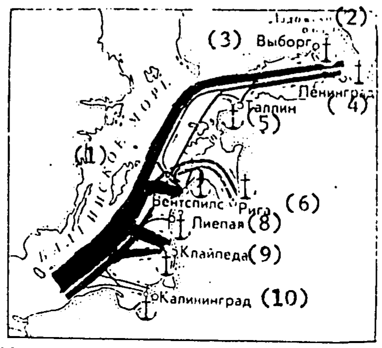

Figure 28. Freight Traffic on the Baltic Sea

1. Baltic Sea
2. Lake Ladoga
3. Vyborg
4. Leningrad
5. Tallin
6. Riga
7. Ventspils
8. Liepaya
9. Klaypeda
10. Kaliningrad

Transportation on the Northern Seas. Among the northern seas, the most important for transportation are the Barents and White Seas. Ports on these seas serve the timber regions of the North, the industrial centers of the Karelian ASSR, the Murmansk and Arkhangel'sk areas. The Northern Sea Route begins in the Barents Sea. (Figure 29) The main port on the Barents Sea is Murmansk, and on the White Sea, Arkhangel'sk. Through them connections are made with other ports in the Soviet Union and also with ports in northern and north-west Europe. The predominant cargoes of the northern ports are timber, coal, apatite, fish, and mineral construction materials. Basically these are the cargoes being hauled on the western part of the Northern Sea Route. The main cargoes shipped abroad are timber and ore.

Of the ports on the other northern seas, the most important are Dikson on the Kara Sea, Dudinka and Igarka which are connected with the Kara through the Yenisey River, Nordvig and Tiksi on the Laptev Sea. The port of Dudinka serves the Noril'sk copper and nickel combine, and Tiksi is an important point for the export of timber. All these ports are connected with the Northern Sea Route. In the ports of Nordvig and Tiksi cargoes are transshipped from river transport. The freight turnover of these ports is significantly less than for the ports of the Barents and White Seas.

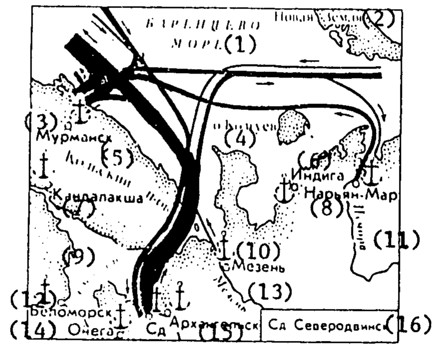

Figure 29. Freight Traffic on the White and Barents Seas.

1. Barents Sea
2. Novaya Zemlya
3. Murmansk
4. Kolguyev Island
5. Kola Peninsula
6. Indiga
7. Kandalaksha
8. Nar'yan-Mar
9. White Sea
10. Mezen'
11. Pechora River
12. Belomorsk
13. Mezen' River
14. Onega
15. Arkhangel'sk
16. Severodvinsk

Transportation on the Seas of the Pacific Ocean. Serving the vast territory of the Far East, transportation on the Pacific Ocean Seas of Japan, and Okhotsk and the Bering Sea is very important. Intersea transport on these seas provides the economic bonds with the Kamchatka, Chukhotsk, and Magadan areas and with the Kurile Islands. The predominant cargoes in the Pacific Ocean basin are coal, petroleum, timber, fish, industrial goods and foodstuffs for the consuming public of the northern region. Cargoes of consumer goods from Pacific Ocean ports flow along the Northern Sea Route. (Figure 30.) Vladivostok, which is at the end of the Northern Sea Route, is the principal port of the Far East. From here, by intersea transport vessels cargoes are sent to Odessa. Besides Vladivostok, the ports of Nakhodka, Sovietskaya Gavan', and Magadan are of great importance, and, on the island of Sakhalin, so are Korsakov and Yuzhno Sakhalinsk. In connection with the increase in the volume of foreign trade, the relative importance of the Far East basin has been raised.

Transportation on the Caspian Sea. The Caspian Sea holds second place in the amount of freight turnover. In distinction from the Black Sea, the Caspian serves mainly for internal transportation. The foreign economic communication carried out by sea with Iran is small. The Caspian Sea connects the regions of the North Caucuses, the Transcaucuses, and the lands along the Volga River with Kazakhstan and Middle Asia. Through the Volga River and the Volga-Don Canal, the Caspian basin connects with the Azov and Black Sea basins and with the Baltic and White Sea basins. (Figure 31) The predominant cargo in Caspian Sea transport is petroleum which is about 90% of

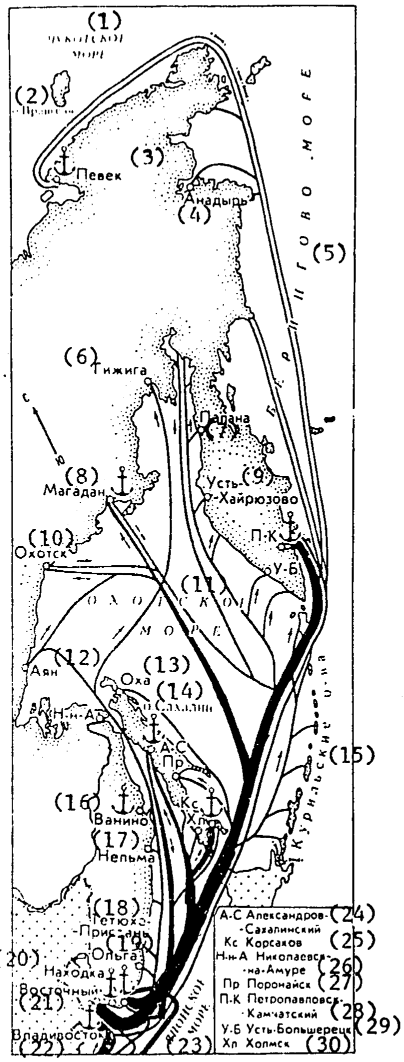

Figure 30. Freight Traffic on the Far Eastern Seas.

1. Chukotsk Sea
2. Wrangel Island
3. Pevek
4. Anadyr'
5. Bering Sea
6. Gizhiga
7. Palana
8. Magadan
9. Ust'-Khayryuzovo
10. Okhotsk
11. Okhotsk Sea
12. Ayan
13. Okha
14. Sakhalin Island
15. Kurile Islands
16. Vanino
17. Nel'ma
18. Tetyukhe-Pristan'
19. Olga
20. Nakhodka
21. Bostochnyy
22. Vladivostok
23. Sea of Japan
24. Aleksandrov-Sakhalinskiy
25. Korsakov
26. Nikolayevsk-on-Amur
27. Poronaysk
28. Petropavlovsk-Kamchatskiy
29. Ust'-Bolsheretsk
30. Kholmsk

the freight turnover in Caspian Sea ports. Most of the petroleum is transported from Baku to Astrakhan' with Magadan next where great quantities are transferred to the railroads. The flow of freight by sea from Baku to Gur'yev and to Krasnovodsk is much less.

The predominant cargoes of the Caspian Sea shipping company are timber, grain, cotton, wool, metals, salt, fish, and mineral construction materials.

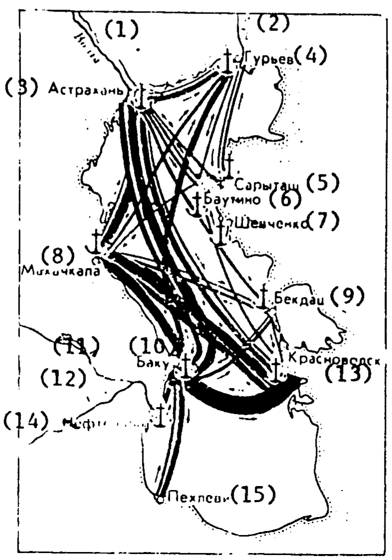

Figure 31. Freight Traffic on the Caspian Sea.

1. Volga River
2. Ural River
3. Astrakhan'
4. Gur'yev
5. Sarytash
6. Bautino
7. Shevchenko
8. Makhachkala
9. Bekdash
10. Baku
11. Kura River
12. Arakses River
13. Krasnovodsk
14. Neftechala
15. Pekhlevi

There is substantial hauling of sodium sulphate which is mined in the Kara Bogaz Gol gulf.

The principal ports of the Caspian are Baku, Astrakhan', Makhachkala, Krasnovodsk, Gur'yev, and Shevchenko.

In freight turnover, Baku, which operates the year around, is the largest port. The principal cargo of Baku is petroleum which is 90% of the turnover in the port, and next is grain. Astrakhan' is the second port in the size of its freight turnover. It is a combined sea and river port. Its importance grew after the construction of the Volga-Don Canal.

Arrivals at Astrakhan' are mainly petroleum, and departures are timber, grain, and salt mainly to Krasnovodsk. In Makhachkala the principal freight turnover is in petroleum, then timber and cotton. The principal freight at Gur'yev is petroleum. (Figure 31)

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MISCELLANEOUS

DEVELOPMENT OF USSR TRANSPORTATION NETWORKS

Moscow VOPROSY EKONOMIKI in Russian No 3, Mar 80 pp 6-15

[Article by A. Mitaishvili]

[Text] The problem of providing the national economy and the population with an efficiently operated transport system is assuming pressing importance. Much work has been done in the Ninth and 10th five-year plans in the USSR to develop all types of transport. Capital investments in the transport system during this period increased 2.7-fold as compared with the Seventh and Eighth five-year plans. We have built and put into operation 15,600 km of second track and new railroad line, 89,000 km of oil and gas mains, 189,000 km of improved road, 29,500 meters of docks in sea- and river ports, and others. We finished providing railroads with electric and thermal power; there was qualitative and quantitative improvement in transport rolling stock. This enabled us to increase transport system freight turnover 3.2-fold in 1978 as compared with 1960.

However, the problem of providing the national economy with an efficiently operating transport system has not been fully solved yet. Transport, and especially rail transport, still does not meet the needs of the national economy and the population for shipment, which leads to disruption of normal technological cycles and to a reduction in production growth and efficiency. According to calculations by the Institute of Comprehensive Transport Problems attached to the USSR Gosplan, the national economic loss just in industrial production as a result of unsatisfied demand for shipment is approximately 6.5 billion rubles per year. Agricultural losses due to the failure to ship promptly and due to spoilage are more than four billion rubles per year.

The situation which has evolved in transport is linked to shortcomings in the work of management agencies, to a lack of proper organization in the operation of the administrative apparatus, to poor monitoring of the observance of technological discipline, and also to the low level of technical armament of transport.

These shortcomings conflict with the advantages of socialist transport, with the socioeconomic unity of all its types based on public ownership of means of transport. These advantages create requisites for and in principle the possibility of planned proportional development of transport. However, the shaping of a unified, highly efficient transport system passes through a number of complex stages associated with the features of the transport itself as a branch of material production, with its territorial attachment, high capital- and labor-intensiveness, and its very long construction cycle.

During the prewar five-year plans, the transport system was created through the preferential development of rail and water transport. Along with renovating the existing rail network, there was considerable new railroad construction and steamships mastered the natural waterways. New types of transport -- motor, air and pipeline -- were developed slowly. During the post-war five-year plans, these types of transport have received priority development. But the rates of new railroad construction slowed considerably. Thus, during the 27 years from 1918 through 1945, the length of the railroads increased by 43,000 km, or 1.76-fold, and in the 32 years from 1946 through 1978 they increased by only 26,300 km, or 23 percent. The length of waterways in use grew by 42,000 and 33,000 km, respectively. The length of improved roads increased by only 7,100 km during the 1918-1945 period and by 342,000 km during the post-war five-year plans. Thus, during the post-war years there has been a substantial slowing of the rate of construction of general-purpose railroads, although that period has been characterized by a sharp increase in the scope of rail shipments and by a shift in production, and especially in the extractive branches, to the east.

The creation of mighty oil- and gas-main systems to pump petroleum and gas from the eastern and northern regions to the Urals and the European portion of the country has enabled us to lessen the load on the railroads, but it has not led to the balanced development of production and transport. In 1978, as compared with 1950, rail freight turnover had increased 5.7-fold, while the length of general-purpose railroads had increased by only 19.5 percent; motor transport freight turnover grew 19.7-fold, while the length of surfaced roads increased 4.2-fold.

The failure to ensure proportionality in developing production and transport branches has caused a substantial lag in the rates of transport development as compared with other branches of the national economy. During the 1940-1978 period, transport production assets grew 11.6-fold, given an increase of more than 20-fold in industry production assets, resulting in a reduction in transport's proportion of fixed production assets. In 1940, transport had 32.2 percent of the national economy's fixed assets; in 1965 it had 21.7 percent, and in 1978 it had only 13 percent. The proportion of rail transport's fixed assets dropped even more: rail transport's share was approximately 27 percent in 1940, but about nine percent in 1978. And transport's proportion of total capital investments also changed correspondingly -- it has decreased nearly four-fold as compared with the 1940 level and 1.7-fold as compared with the 1960 level.

Proportions within the transport system have also changed significantly. Rail transport's share of total capital investments dropped from 50.5 percent during the prewar five-year plans to 28.6 percent in the post-war period. There has been a reduction in the proportion of transport fixed assets, although rail transport's proportion of total freight turnover has been nearly 60 percent.

Rail freight turnover during recent five-year plans has considerably exceeded the rates of increment in throughput capacity. During the Eighth Five-Year Plan, the increment in calculated freight turnover (total ton-kilometers and passenger-kilometers) was 860.5 billion ton-kilometers, and the throughput capacity of the railroads was 686 billion ton-kilometers. In this regard, the throughput capacity of the railroads increased by only 65 billion ton-kilometers, or 9.5 percent, through the construction of second tracks and new railroads. The remaining increment was ensured by increasing the weight of freight trains, introducing automatic block signaling and by rail electrification.

The railroad network throughput capacity increment was increased in the Ninth Five-Year Plan: by 171 billion ton-kilometers through construction of second tracks and new railroads and by a total of 823 billion ton-kilometers, given growth of 977 billion ton-kilometers in calculated freight turnover. Consequently, the rates of rail transport freight turnover increment during this period considerably outstripped the growth rates of its throughput capacity, which led to the exhausting of available technological reserves on the main railroad lines.

The lag in rail transport throughput and shipping capacity has not been compensated for by accelerated development of pipeline transport. Pipeline transport services two branches of industry -- petroleum and gas; rail transport services all branches of the national economy and all regions of the country.

Providing the country with transport-economic links depends on the level of development, mobility and maneuverability of the railroads. Therefore, the slightest break in the rhythm of their operation can lead to disruption of the optimum functioning of production, distribution and exchange. This predetermines the necessity of outstripping rates of development of transport as the production infrastructure of the national economy. In the past, failure to consider this requirement when planning the proportional development of transport and other branches of the national economy, on the one hand, and proportions within types of the transport system, on the other, has significantly determined the difficulties which have now developed in the operation of transport.

The task of accelerating development of a highly efficient transport system for the country now moves to the fore. Such a system means an economically balanced aggregate of all types of transport (rail, water, motor, air and pipeline) serving the economic ties of enterprises and organizations and continuing the production process in the circulation sphere. Such transport balance can be achieved only if each type of transport is used in the area in which it is most advantageous and ensures fullest satisfaction of the growing requirements of the population and the national economy for shipments. In planning the communications network, full consideration must be given to structural and territorial shifts in production and consumption, to long-range interregional and intraregional economic ties.

At the November (1979) CPSU Central Committee Plenum, L. I. Brezhnev noted that successful completion of work on planning the transport system requires the development and implementation of a scientifically substantiated long-range target program whose basis must be a comprehensive approach to solving this problem. But the general transport development plans being worked out by planning and scientific-research institutes of various departments do not agree with one another, are not coordinated. The situation is similar in planning transport construction projects -- each departmental planning organization is working out plans for projects for a given type of transport. Even the transport centers at the junctions of different types of transport are developed by departmental affiliation. This leads to an increase in expenditures of labor and materials, to delay in comprehensively solving problems of developing the USSR transport system. In the future, in order to avoid errors in creating a highly efficient transport system as a unified complex, it will be necessary to work out a long-range target program of transport development and management.

The communications network and transport centers will be the basis of transport. Expenditures on overcoming the disproportions which have evolved between the level of development of throughput and shipping capacity and the volume of shipments must comprise the investment basis of a long-range target comprehensive program of planning and developing the country's transport system. Dynamic development of all branches of the national economy requires corresponding development of communications and the creation of transport centers.

The USSR is now producing more than 21 percent of the world's industrial output, but its communications comprise less than seven percent of the world rail and first-class highway network. In 1978, USSR rail density per 1,000 km^2 was 6.3 km, and its improved road density -- 16.2 km. In the developed capitalist countries, these indicators are substantially higher. For example, the rail network density in the USA was 37.5 km in 1976, in Great Britain -- 78.5 km, in the FRG -- 128 km, and in France -- 62.2 km. Moreover, indicators of road network saturation are also higher in these countries. In this regard, Soviet railroads carried 54.3 percent of the world's freight in 1978, which was 2.8-fold higher than the rail freight turnover of the USA. Average shipment density in the USSR in 1978 exceeded 24 million ton-kilometers per kilometer of track (60-80 million ton-kilometers on the main freight-turnover lines), which was 6.3-fold higher than the average freight load on U.S. railroads. These data bear out the fact that the technical base of the railroads in our country is being used better than in foreign countries. However, the extremely high freight load level has negative aspects: there are interruptions in the rhythm of train movement; there is limited maneuverability and mobility, resulting in slow rolling stock circulation; speeds are reduced.

Putting the transport network on a main-route basis is the primary direction of its long-range development. However, it must be supplemented by the accelerated development of the transport infrastructure of production-territorial and agroindustrial complexes. Along with renovating the existing network, we must develop trunk lines more rapidly in new industrial regions in parallel with those existing in the European portion of the country and in the Urals. The supply and delivery network must correspond to these trunk lines. Solving the problem this way will enable us to meet the requirements of the national economy for transport and to lower transport outlays.

Research by the Institute of Comprehensive Transport Problems attached to the USSR Gosplan has established that increasing the amount of shipment on two-track trunk lines over 60-70 million tons per year in one direction is inefficient since compacting train traffic schedules and increasing the number of train pairs leads to retardation of rolling stock circulation, reduction in speed, longer maintenance times, more expensive maintenance, and poorer operating conditions.

Increased communications network throughput capacity is required on all interregional and intraregional lines, as well as on approaches to river- and seaports and on approaches to border transport centers. However, the nature of transport network development differs substantially by region of the country and by type of transport. In the European portion of the country, development of the communications network must occur primarily by increasing the throughput capacity of existing lines by building second lines. Through and by-pass lines must be built here to create new parallel trunk lines and to increase the maneuverability of the network. In the Urals region and the South Urals - Volga Area polygon, we need to increase the network throughput capacity by building a new latitudinal railroad. We should examine the question of creating in the 11th and 12th five-year plans a "discharge" trunk line between the Kazan' and Perm' lines, subsequently continuing this line east through the Urals and northern Sverdlovsk and coming out at the Vagayskiy line near Tyumen'. We need to outline the development of a transit "discharge" route around overloaded sectors and junctions in the Center and the Ukraine, using the existing network as a base. By building second tracks in stages, we can ensure a transit "discharge" route from the Donets Basin and Krivoy-Rog to the western border using the existing network as a base.

Moreover, we need to create specialized passenger trunk lines from the Center to the Caucasus and from the Center to the Crimea. This problem must be solved either by building a new line from Michurinsk to Mineral'nyye Vody using individual relatively inactive existing sectors or by redistributing shipments and specializing existing trunk lines and simultaneously introducing a transit Donets Basin crossing isolated from local operation and a wide Rostov junction by-pass. In our opinion, the second variant is the most efficient in terms of passenger services cost and quality.

Positive results have been achieved in improving the main highways connecting the major industrial and cultural centers of the European part of the country. Unfortunately, the same cannot be said of development of the network of improved local roads, especially in rural regions. Many population centers, kolkhozes and sovkhozes, and individual rayon centers are not connected by improved roads. The price cost of motor shipments on improved roads is nearly three-fold less than on cobblestone roads. In this regard, the productivity per vehicle on higher-class roads is 3.4-fold higher than on dirt roads. Eliminating the lack of roads in many regions would enable us to reduce the demand for freight motor transport by 575,000 to 600,000 vehicles and to reduce the transport outlays of the national economy by approximately seven billion rubles.

Developing the network of main and transfer petroleum product pipelines is an important task. The distribution of petroleum product shipments between rail and pipeline transport which has evolved cannot be considered efficient. Under present conditions, the railroads account for more than 90 percent of such shipments, while specific expenditures on shipping petroleum products by rail are 80 percent higher than for shipment by pipeline. This fact must be considered when determining the program for developing the communications network and distributing shipments among the different types of transport.

The long-range target program must anticipate complete elimination of the disproportion which has evolved between the shipping capacity of the sea and river transport fleet and the processing capacity of the ports by increasing the number of comprehensively mechanized docks at existing ports and by building new ones.

The question of developing the transport network in eastern regions of the country, in which the development of transport and especially rail and motor transport is lagging behind the rates of industrial development, is becoming urgent. The largest regions of the country, those possessing enormous economic potential, cannot be drawn fully into economic circulation due to the poor development of transport communications. It is known that 90 percent of the country's fuel and energy resources, which are consumed basically in the European portion of the country and in the Urals, is concentrated in the eastern regions. Great distances lead to difficulties in supplying the processing industry of the European portion of the country with fuel.

Transport utilization of the new regions has been effected by systematically using different types of trunk-line and local transport. The process of developing reliable transport communications to ensure importation into newly developed regions of material and technical freight and the exportation of finished products has been carried out incompletely and with delays. One example would be the creation of a system of communications for the petroleum and gas regions of the Western Siberian lowlands. Until recently, river transport was the sole means of large-scale importation of freight here, since the organization of steamship lines required the least expenditures. Pipeline transport became the second type of main-line transport for the region, ensuring the shipment of crude petroleum and gas to the Urals and European regions of the country. The railroad track from Tyumen' to Surgut was laid very much behind schedule. The laying of track to the new petroleum and gas regions is lagging behind the growth rate of petroleum and gas extraction. The problem of providing the complex with transport has not been solved. Installation of the rail trunk line from Surgut to Urengoy and on to Noril'sk is an urgent problem in the overall strategy of utilizing the petroleum and gas regions of the Siberian North.

Installation of the Baykal-Amur Trunk Line assumes a fundamentally different way of utilizing the new regions of Siberia and the Far East. The development of economic complexes in the BAM zone can occur either simultaneously with the construction of railroads which ensure stable, year-around transport links to an extensive area and permitting a significant reduction in the time involved in industrial utilization of the natural resources of the adjacent territory or industrial utilization of the natural resources will be preceded by the creation of transport communications.

The Baykal-Amur Railroad will enable us to create a major industrial base of more than 1.5 million square kilometers on the basis of using rich natural resources. The BAM will facilitate strengthening the economic ties between western and eastern regions of the country and will provide a second outlet to the Pacific Ocean coast. Its construction will be a first stage in shaping the region's support network, which will also have an independent importance in utilizing the natural resources of individual regions in which the trunk line is being built.

It is proposed that the BAM be used as a base for utilizing a number of major deposits of minerals, including the South-Yakutsk anthracite coal basin, the South-Aldansk and Chara-Tokkinsk iron ore regions, the Udkansk copper ore deposit, tungsten and molybdenum deposits in the Transbaykal, phosphorite deposits in Udeno-Selemdzhinskiy Rayon. Utilization of these natural riches will require the installation of very long railroads, a number of meridional railroad lines north from the BAM route. The Tynda-Berkakit line should be continued into the Aldan area and subsequently on to Yakutsk. As the economy of the zone adjacent to the BAM develops, it will become necessary to build other transport lines, as well as new seaports in the Primor'ye.

In the long-range comprehensive program, the problem of creating transport communications to ship anthracite coal from the Kuznetsk and Kansko-Achinsk basins to Urals regions and the European portion of the country must be solved through the coordinated development of various types of transport -- rail, pipeline, and high-voltage electric power transmission lines (LEP). However, in the next 5-10 years, we will not be able to fully resolve the task of transporting coal in the required quantities by LEP's and pipelines. The development of a specialized rail trunk line to ship bulk freight using the Central Siberian Railroad as a base, with simultaneous strengthening of outlets from Central Siberia to the West, is therefore urgent. Disproportions in the development of the remaining links of the latitudinal polygon from Eastern Siberia to the Urals must be eliminated by building second tracks throughout the entire length of the eastern portion of the South Siberian Trunk Line. We must simultaneously develop electric power transmission lines and begin installing a pulp line to the Urals, subsequently laying a second line to Volga area regions.

Calculations made at the Institute of Comprehensive Transport Problems show that it is most economical to produce electric power where the coal is mined and to transmit it to regions of the Volga area and the Center. Expenditures on moving coal in pulp lines are close to these expenditures. However, the complexity of the technical solutions to many problems make their implementation more remote. At the same time, acceleration of the choice of an optimum variant becomes an important task, since supplying regions of the Urals, the Volga area and the Center with fuel and energy resources of the Kansko-Achinsk basin is urgent.

Providing regions of Siberia and the Far East with transport requires the accelerated development of sea and river transport. In order to set up year-around navigation on the North Sea route, considerable expenditures are needed to build large ice-breakers and transport vessels with reinforcement to deal with ice, to install ports and port-centers. This will enable us to ensure uninterrupted deliveries of freight from new industrial regions and shipment of finished output out of them. In this regard, it is appropriate to use oceangoing transport barges with self-propelled platforms or air-cushion vessels.

Development of an optimally-functioning transport system is associated with proper determination of the places and spheres of use of all types of transport. Each is characterized by technical and economic features which affect their efficiency indicators. Technical-economic calculations and the compilation of different variants of transport services to the population and the national economy and selection of criteria of the effectiveness of distributing shipments among them should be done with consideration of these factors.

Under present conditions, society does not yet have available to it opportunities for fully providing all the material and labor resources for the outstripping development of the transport system as a whole as the most capital-intensive system. The comprehensive development of all types of transport therefore remains a pressing problem.

The long-range target program of transport system development such anticipate a combination of types of transport whose comprehensive development is most efficient and will qualitatively meet social requirements for shipments both nationwide and by each region. Many scientific and planning organizations are involved in defining indicators, criteria and effectiveness both of transport as a whole and of individual types of transport, but these questions have not yet been suitably resolved. At the same time, the territorial distribution, concentration and specialization of production depend largely on the accuracy of evaluations of socially necessary expenditures.

The accepted method of calculating socially necessary expenditures on transport is by using so-called additionally-arising expenditures. The socially necessary shipment expenditures calculated using this method do not take into account outlays on maintaining permanent transport facilities, so they are below actual expenditures for all types of transport and on all lines of the network, especially for railroads. This is associated with the fact that full socially necessary railroad expenditures do not take into account the proportion of permanent facilities, which is approximately 40-42 percent. The failure to take these expenditures into account in sector tariffs leads to a situation in which network sector outlays are 35-40 percent lower than full socially necessary expenditures. Calculation of the economic indicators and determination of the spheres of use of types of transport must be done using actual socially necessary expenditures.

When improving the structure of the transport system and determining the role of each type of transport, along with calculating specific calculated expenditures, consideration must also be given to indicators of the protection of freight being shipped and to the speed with which it is delivered. It is especially important to take them into account when planning freight shipments using two or more types of transport. Expenditures connected with making good losses of or damage to freight during shipment must be totalled and added to expenditures connected directly with shipment. Losses or deterioration of freight during transport increase total national economic outlays.

The speed with which freight is delivered is of considerable importance in establishing the spheres of application of various types of transport. The faster the speed of movement, the lower the level of frozen circulating capital in the transport process.

In the 1960's and early 1970's, the speed of freight movement increased and the circulation of material resources accelerated. Sector speed on the railroads increased from 28.3 km per day in 1960 to 33.5 km in 1970. That led to the freeing of nearly three billion rubles worth of material resources for other uses. However, beginning in the late 1970's and especially in the initial years of the 10th Five-Year Plan, transport operation deteriorated. Speed of movement dropped and average freight car circulation increased from 5.2 days in 1965 to 6.25 days in 1977, which led to an increase totalling about four billion rubles in circulating capital in goods shipped.

Under present conditions, the structure and effectiveness of general-purpose transport are characterized by the following data [in the table on the following page].

In the long term, under the impact of scientific and technical progress, the dominant importance of any one or two types of transport will decrease. This will be facilitated by the extensive use of pipeline transport, not only to pump crude petroleum and petroleum products, but also to transport such bulk freight as coal, ore, mineral building materials and other materials, primarily over short and medium distances.

type of transport	proportion (in percent)		economic indicators (in kopecks per 10 calculated ton-kilometers)		
	freight turnover	passenger turnover	operating expenses	specific capital investment	calculated expenses
rail	57.7	40.4	2.94	34.4	7.1
sea	13.9	0.3	2.59	31.4	6.4
oil pipeline	17.6	--	0.78	9.2	1.7
motor	6.6	41.6	48.27*	42.0*	53.3*
river	4.1	0.7	2.96	52.3	9.2

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*general-purpose motor transport, excluding roads

Research and the domestic and foreign experience accumulated show that pipeline pneumocontainer and hydraulic transport can ensure a substantial reduction in transport expenditures as compared with motor and rail transport, that it can free considerable labor resources for other work and reduce negative effects on the environment. According to calculations from the Institute of Comprehensive Transport Problems, labor productivity in pipeline transport is 20-fold higher than in motor transport and prime cost is 2.5-fold lower.

Under the impact of scientific and technical progress, we can expect an increase in the proportion of finished and semifinished products in the structure of freight being shipped, which will elicit a redistribution of shipments among all types of transport in favor of those types which ensure a reduction in delivery time, and especially in unloading and loading time. It will become more efficient to ship such "general" freight by motor transport over short and medium distances. This type of transport can ensure not only faster delivery, but also better protection of freight and a reduction in loading and unloading expenditures, especially for freight shipped on a "motor-rail-motor" plan. The proportion of rail transport will drop somewhat, but railroads will continue to retain their leading role in the structure of the country's transport system.

Changes in the transport structure are linked both to continued strengthening of specialized types of transport and to development of means of transport. A requisite for creating an efficient national transport system is improvement in technical means, in the technology of the shipment process. The basic direction in which the technical means of transport will be improved will be to increase the load capacity and power of transport units and rolling stock. To this end, it will be necessary to improve the structure of the rolling stock fleet by broadly specializing it, continuing the policy of electrification of heavily loaded railroad lines. In order to increase the weight of freight trains, we will need to increase the unit and section power of the locomotive fleet. We must ensure the production of 10,000 h.p. and higher electric locomotives and 8,000 h.p. diesel engines. The problem of increasing the reliability of diesel locomotives and electric traction motors is urgent. Due to their poor quality, the amount of repair work in 1977 had increased 60 percent as compared with 1975 and the labor-intensiveness of locomotive maintenance had risen four-fold.

Along with increasing the power of locomotives, we need to develop new freight cars adapted to the changing structure of the freight being shipped, as for example, eight-axle gondola cars and tank cars. The linear load of such gondola and tank cars is 25-30 percent higher than for four-axle cars of the same type. Trains made up of eight-axle cars increase shipping capacity by 35-40 percent. According to calculations by the Institute of Comprehensive Transport Problems, the proportion of specialized cars should be increased from the 15 percent in 1975 to 20-22 percent by 1985. This will enable us to significantly reduce losses and deterioration of freight during transport.

The effectiveness of shipment by water also depends on growth in ship load capacity and power and on ship specialization. It is necessary to increase the proportion of specialized container ships, trailer-hauler ships in a horizontal adaptation, stacked-lumber ships, and others.

In motor transport, along with improvement in fleet structure by increasing the proportion of small (up to two-ton) and large (over five-ton) vehicles, we should ensure the release of trucks with axle loads of six tons and more, as well as expanding production of trailers and removable truck-chassis bodies, and also specialized vehicles and trailers.

Increasing the number of diesel vehicles and producing electric vehicles are important tasks. The switching of vehicles from gasoline to diesel engines will permit reducing fuel expenditure by approximately 30 percent as compared with carburetor engines and significantly reducing environmental pollution. At present, only vehicles with load capacities of more than six tons are provided with diesel engines. Such vehicles comprise less than eight percent of the total fleet.

The creation of a highly efficient transport system and optimization of its structure will require, as L. I. Brezhnev pointed out at the 25th CPSU Congress, "the allocation of considerable resources to accelerate the development of transport, communications, the material supply system -- of everything called the infrastructure."

Improving transport efficiency and quality is associated with substantial improvement in the use of means of shipment, with optimizing transport-economic ties, with eliminating inefficient shipments, with ensuring the necessary proportionality of development of different types of transport and their coordinated operation, with introducing progressive new shipment methods and comprehensively mechanizing loading and unloading work, with developing and broadly introducing means of automation, telemechanics and automated shipment systems.

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